Space Weather Technical Forecast

Issued on Monday 31 March 2025 at 13:36 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

---

Space Weather Forecast Headline: Minor/Moderate (R1/R2) radio blackouts Expected. Ongoing Active electron fluence.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was High, with five low-level M-class flares observed, all from AR4048 in the southeast. The peak flare was an M1.6 class flare at 30/1642 UTC. There are seven sunspot regions on the visible disc, the most prominent of which was AR4048. Continued growth and consolation of spots was observed in its intermediate region, although magnetic shearing of the spots appears somewhat limited. Elsewhere, AR4043 and AR4044, in the northern central quadrant, maintained modest complexity and size, although appeared largely inactive. AR4046, in the northeast retained a large main spot, along with numerous much smaller spots or pores of mixed polarity. The remaining regions on the disc are smaller and more magnetically simple, including newly numbered AR4049 in the southeast.

Solar Wind / Geomagnetic Activity: Solar wind parameters, as measured by ACE at L1, were indicative of gradual waning fast winds, emanating from CH25/+, followed by a CME enhancement, starting around 31/1015 UTC. Solar wind speeds were slightly elevated to slow-ambient, with a peak of 494km/s at 31/1128 UTC. The solar wind density was largely below average. The Interplanetary Magnetic Field, Bt, was predominantly Weak, but with an increase to Moderate levels following passage of the CME, peaking nearly 12nT at 31/1105 UTC. The north-south component, Bz, varied between +/-6 nT. The phi angle was positive (away from the Sun) throughout. Geomagnetic activity was largely Quiet (Kp1-2), but an Active (Kp4) interval was observed between 31/0900-1200 UTC.

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) at GOES18 briefly reached the S1/Minor Storm threshold between 31/1105-1115 UTC, otherwise has been at normal background levels. High energy electron flux (greater than 2 MeV) at GEO varied between Moderate and High levels, peaking at 2770pfu at 30/1715UTC. The 24-hour integrated fluence remained above the Active threshold throughout, on a slowly declining trend, with the observed 24-hour integrated fluence 1.46e8pfu at 30/2359UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate to High activity is forecast with occasional to frequent M-class flares expected and a slight chance of isolated X-class flares, mainly from AR4048.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2025. All Rights Reserved.

Solar Wind / Geomagnetic Activity: Solar winds are generally expected to decline in the coming days, following recent HSS and CME enhancements, with speeds mainly at slightly elevated levels. Speeds may then increase to become more persistently slightly elevated from either Day 2 or Day 3 (01 or 02 Apr) owing to the expected connection to a relatively small coronal hole (CH28/+) before likely declining again on Day 4 (03 Apr). Most CMEs in the last 24-48 hours are expected to miss Earth, however a slow CME from 29 Mar may be directed towards Earth, forecast to arrive during Day 3 (02 Apr).

Overall, predominantly Quiet to Unsettled geomagnetic activity is forecast through the period. However, there is a chance of isolated Active intervals and a slight chance of G1/Minor storm periods, mainly between Days 1-3 (31 Mar to 02 Apr) due to potential CME or HSS influences.

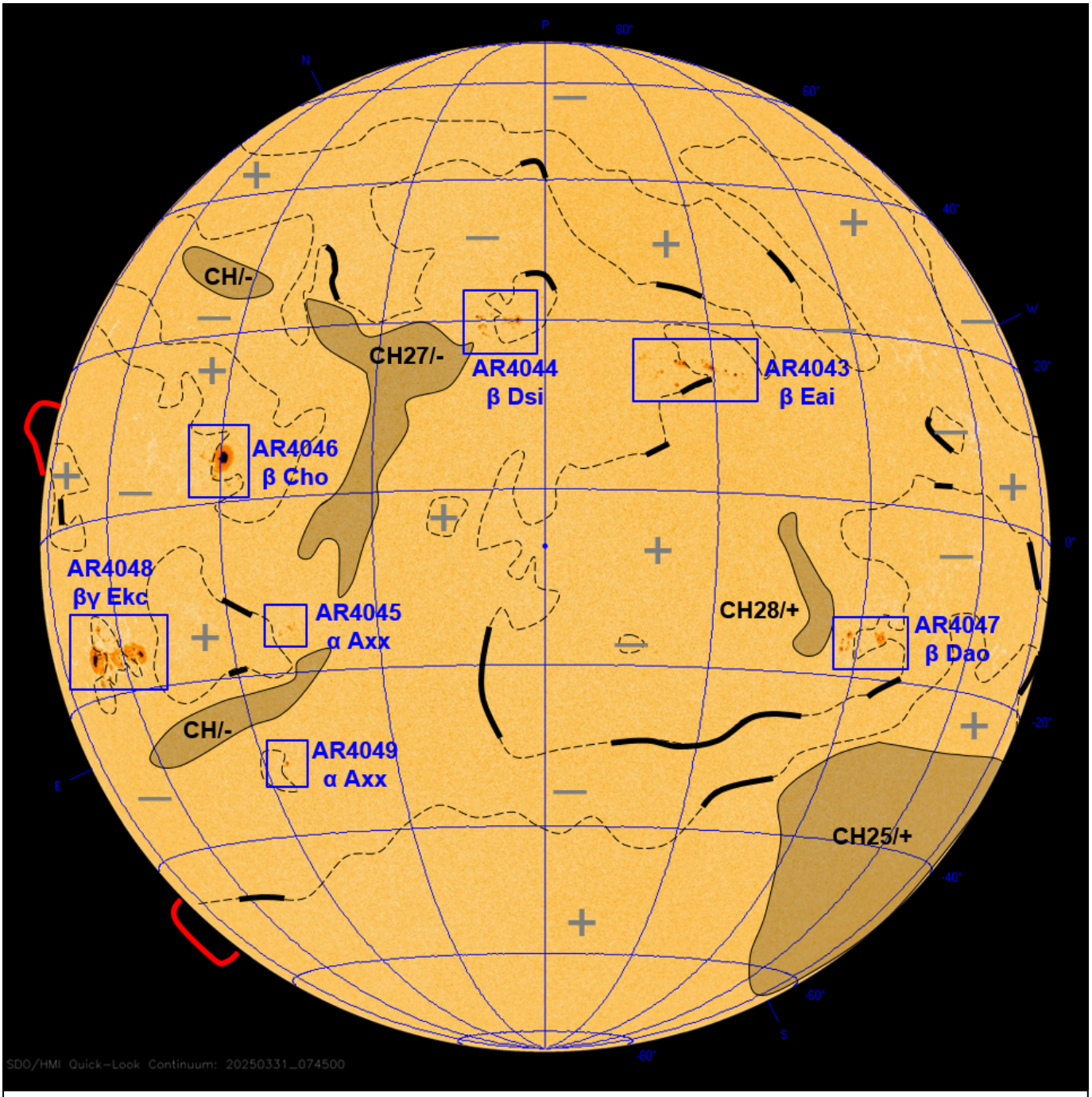
Energetic Particles / Solar Radiation: High energy proton flux briefly reached S1/Minor Storm levels on Day 1 (31 Mar) due to a recent CME arrival, however, levels have since fallen back below this threshold. Although proton flux levels are expected to gradually decrease in the coming days, there remains a slight chance of exceeding the S1/Minor Storm threshold between Days 2-4 (01-03 Apr) should any further notable flares occur.

High energy electron flux levels are fluctuating between Moderate and High levels with current electron fluence above the Active threshold. With time both electron flux and fluence are expected to lower below notable thresholds, assisted by HSS and potential CME influences.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2025. All Rights Reserved.

Figure 1: MOSWOC Solar Synoptic Map valid 31/0745 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2025. All Rights Reserved.

Geomagnetic Storms

Various CMEs appear to have left the Sun in the last 48 hours, however, most, if not all, appear to be directed away from Earth. A recent enhancement to solar wind parameters (around 31/1015 UTC) is most likely attributable to a glancing impact from the CME related to the X1.1 flare at 28/1520 UTC, off the eastern limb in the vicinity of AR4046. There is still the potential for a further Earth-directed CME, that left the Sun on 29 Mar, from the centre disc close to AR4043, though due to lack of triangulating imagery and a very faint signature this is very low confidence. Any arrival could bring a risk of enhanced geomagnetic activity on Day 3 (02 Apr). A CME also appears to have left the southeast limb on 29 Mar at around 2300 UTC (possibly in association with the M1.9 flare from AR4048), this is expected to pass behind Earth's orbit. A rather fast CME then left the Sun later on 30 Mar from the northwest limb. Confidence is high that this will pass ahead of Earth.

Solar winds have been gradually easing as the connection to large CH25/+ wanes, but has recently been bolstered to around 450-500km/s by the CME arrival early on 31 Mar. There is a likely connection to small CH28/+, either starting Day 2 (01 Apr) or early Day 3 (02 Apr). Enlil is modelling this feature, however, forecast speeds (of 550-600km/s) exceed expected levels, possibly contaminated by a moderately-fast CME at a similar period relative to recurrence in the previous month. This means that the onset of the HSS is likely to occur later than indicated in Enlil (31 Mar). Overall, currently slightly elevated solar winds are expected to slowly decline through the remainder of Day 1 and 2 (31 Mar and 01 Apr), perhaps reaching slow-ambient levels for a time, before reaching persistently slightly elevated speeds either later Day 2 (01 Apr), or more likely on Day 3 (02 Apr). Speeds may start to decline again before the end of Day 4 (03 Apr)

Overall, predominantly Quiet to Unsettled geomagnetic activity is forecast through the period. However, there is a chance of isolated Active intervals and a slight chance of G1/Minor storm periods, mainly between Days 1-3 (31 Mar to 02 Apr) due to potential CME or HSS influences.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	20	20	5
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2025. All Rights Reserved.

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R⊙ (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed (km/s)	Estimated Arrival Time (UTC)	Comments
30/0800 UTC	Partial	Flare	North Centre	425	02/0000UTC	Very low confidence. Lack of triangulating imagery.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2025. All Rights Reserved.

Radio Blackouts - X-Ray Flares

Solar activity is High, with five low-level M-class flares observed in the past 24-hours, all from AR4048. The peak flare was an M1.6 flare at 30/1642 UTC.

There are seven sunspot regions on the visible disc. The most prominent of which is AR4048. Previously responsible for multiple M-class flares and located in the southeast, it is a large region with numerous strong spots of mixed polarity. Continued growth and consolation of spots has been observed in its intermediate region, although magnetic shearing appears somewhat limited at this time. Elsewhere, AR4043 and AR4044, in the northern central quadrant, maintain modest complexity and size, although appear largely inactive. AR4046, in the northeast includes a large main spot, along with numerous much smaller spots or pores of mixed polarity. This region was responsible for the X1.1 flare on 28 Mar, but activity has reduced since this time. The remaining regions on the disc are smaller and more magnetically simple, including newly numbered AR4049 in the southeast.

No significant regions are forecast to depart the visible disc during the four-day period, and no strong far-sided regions are expected to rotate over the eastern limb, meaning a level trend in flare probabilities in the period. Moderate to High activity is forecast with occasional to frequent M-class flares expected and a slight chance of isolated X-class flares, mainly from AR4048.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	80	80	80	80
Very Active	R3-R5 (X Class)	No	15	15	15	15

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

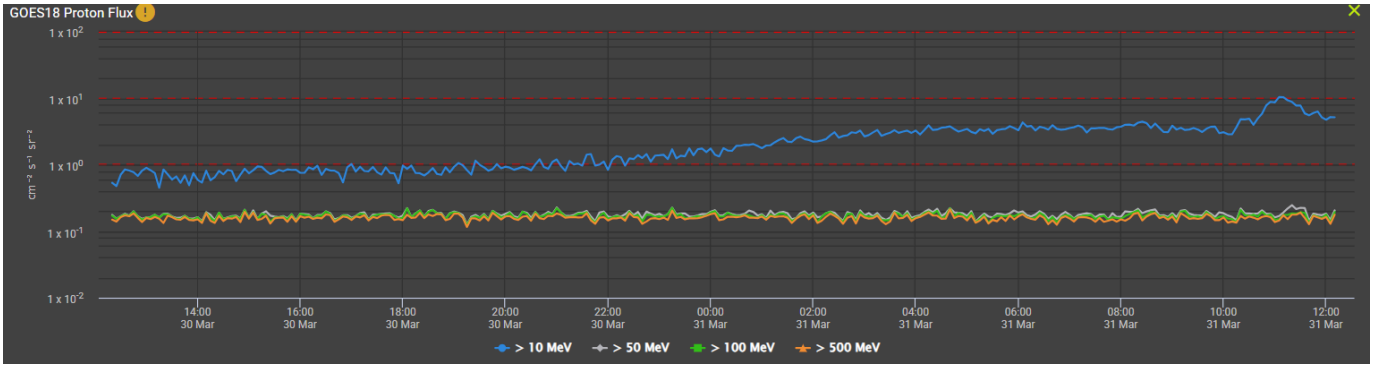
© Crown Copyright 2025. All Rights Reserved.

Solar Radiation Storms (High Energy Protons)

GOES18 high energy (>10MeV) proton flux briefly reached S1/Minor Storm levels on Day 1 (31 Mar) owing to a recent CME arrival, however, levels have since fallen back below this threshold. Although proton flux levels are expected to gradually decrease in the coming days, there remains a slight chance of exceeding the S1/Minor Storm threshold between Days 2-4 (01-03 Apr) should any further proton-rich flares occur, mainly from AR4048.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	100	20	20	20
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 2: Latest GOES18 Proton Flux observations. Flux briefly exceeding S1/Minor Storm threshold around 31/1100 UTC.



Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2025. All Rights Reserved.

High Energy Electrons (≥ 2MeV)

High energy electron flux (greater than 2 MeV) has been above the High threshold for the past 24 hours and will continue above the threshold initially, but with a reducing trend. This is, in part, due to the easing of the HSS from CH25/+ at Earth, but also some minor CME influence. Any enhanced geomagnetic activity from a connection to the next CH28/+ beginning on Day 2 or 3 (01 or 02 Apr) and the possibility of a CME arrival on Day 3 (02 Apr), may serve to 'knock-down' electron counts at GEO. Active levels of the 24-hour integrated fluence has been observed since 29/1500 UTC and is forecast to remain Active through Days 1 and potentially much of Day 2 (31 Mar and 01 Apr), before likely falling below this threshold from Day 3 (02 Apr) onward.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	Yes	100	95	40	30
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2025. All Rights Reserved.

Figure 3: Latest GOES16 >2MeV Electron flux (above) and MOSWOC REFM forecast with Recurrence (below). REFM likely too quick to lower electron fluence in the next couple of days.

Issued by Met Office Space Weather Advisor, Tel: +44 (0) 370 900 0100 Email: enquiries@metoffice.gov.uk

© Crown Copyright 2025. All Rights Reserved.